WHAT IS CLAIMED IS:

1. A synchronous machine comprising:

a rotor coupled to a rotor cooling system;

a stator around the rotor and separated from the rotor by an annular gap between the rotor and an inner surface of the stator, and

a stator ventilation system separate and independent of the rotor cooling system.

2. A synchronous machine as in claim 1 wherein the stator ventilation system injects cooling gas into the stator and said cooling gas flows through the stator and exits the stator at the annular gap.

3. A synchronous machine as in claims 2 wherein the cooling gas flows through stator gas passages.

4. A synchronous machine as in claim 1 wherein said ventilation system further comprises a heat exchanger.

5. A synchronous machine as in claim 1 wherein said rotor comprises a superconducting coil, and said rotor cooling system provides cryogenic cooling fluid to said coil.

6. A synchronous machine as in claim 1 which is an electromagnetic generator.

7. A synchronous machine as in claim 1 which is a motor.

8. A synchronous machine as in claim 1 wherein said ventilation system is a reverse flow ventilation system.

9. A synchronous machine as in claim 1 wherein said ventilation system is a closed-loop system in which cooling gas circulates through the stator and a heat exchanger in a flow path of the gas.

10. A synchronous machine as in claim 1 wherein said ventilation system is an open-loop system in which cooling gas passes through the stator and the air gap, and exhausts to an environment outside of the machine.

11. A superconducting electromagnetic machine comprising:

a solid core rotor having a cryogenically cooled superconducting rotor coil winding;

a stator coaxial with said rotor and having stator coils magnetically coupled with said superconducting rotor coil winding, said stator coils arranged around said rotor, and said stator having cooling passages extending from an outer periphery of the stator to an inner periphery of the stator, said inner periphery separated from the rotor by an annular air gap;

said rotor having cooling passages for cryogenic cooling fluid;

a stator ventilation system providing cooling gas to said outer periphery of the stator and said passages of the stator.

12. A superconducting electromagnetic machine as in claim 11 wherein the cooling gas exits the stator at outlets in the passages open to the annular air gap.

13. A superconducting electromagnetic machine as in claims 11 wherein said ventilation system further comprises a heat exchanger.

14. A superconducting electromagnetic machine as in claim 11 wherein said rotor comprises a superconducting coil, and said rotor cooling system provides cryogenic cooling fluid to said coil.

15. A superconducting electromagnetic machine as in claim 11 which is an electromagnetic generator.

16. A synchronous machine as in claim 11 which is a motor.

17. A superconducting electromagnetic machine as in claim 11 wherein said ventilation system is a reverse flow ventilation system.

18. A superconducting electromagnetic machine as in claim 11 wherein said ventilation system is a closed-loop system in which cooling gas circulates through the stator and a heat exchanger in a flow path of the gas.

19. A superconducting electromagnetic machine as in claim 11 wherein said stator cooling passages are adjacent and orthogonal to said stator coils.

20. A method for cooling a superconducting electromagnetic machine having a solid core rotor including a superconducting rotor coil winding and a stator and a stator ventilation system, said method comprising the steps of:

a. cryogenically cooling the rotor coil winding independently of cooling the stator;

b. cooling the stator with a cooling gas flowing through the stator, and

c. drawing the cooling gas out of the stator into a air gap between the stator and rotor core, where the cooling gas is isolated from any rotor cooling system.

21. A method for cooling as in claim 20 wherein the cooling gas flows into an outer periphery of the stator, through the stator cooling gas passages and out into the air gap.

22. A method for cooling as in claim 20 wherein said cooling gas is drawn by a fan out of the air gap and is exhausted out of the machine.

23. A method for cooling as in claim 20 wherein said cooling gas is drawn by a fan out of the air gap and is directed to a heat exchanger, and said method further comprises extracting heat from the cooling gas by the heat exchanger, and circulating the cooling gas through the stator and heat exchanger.